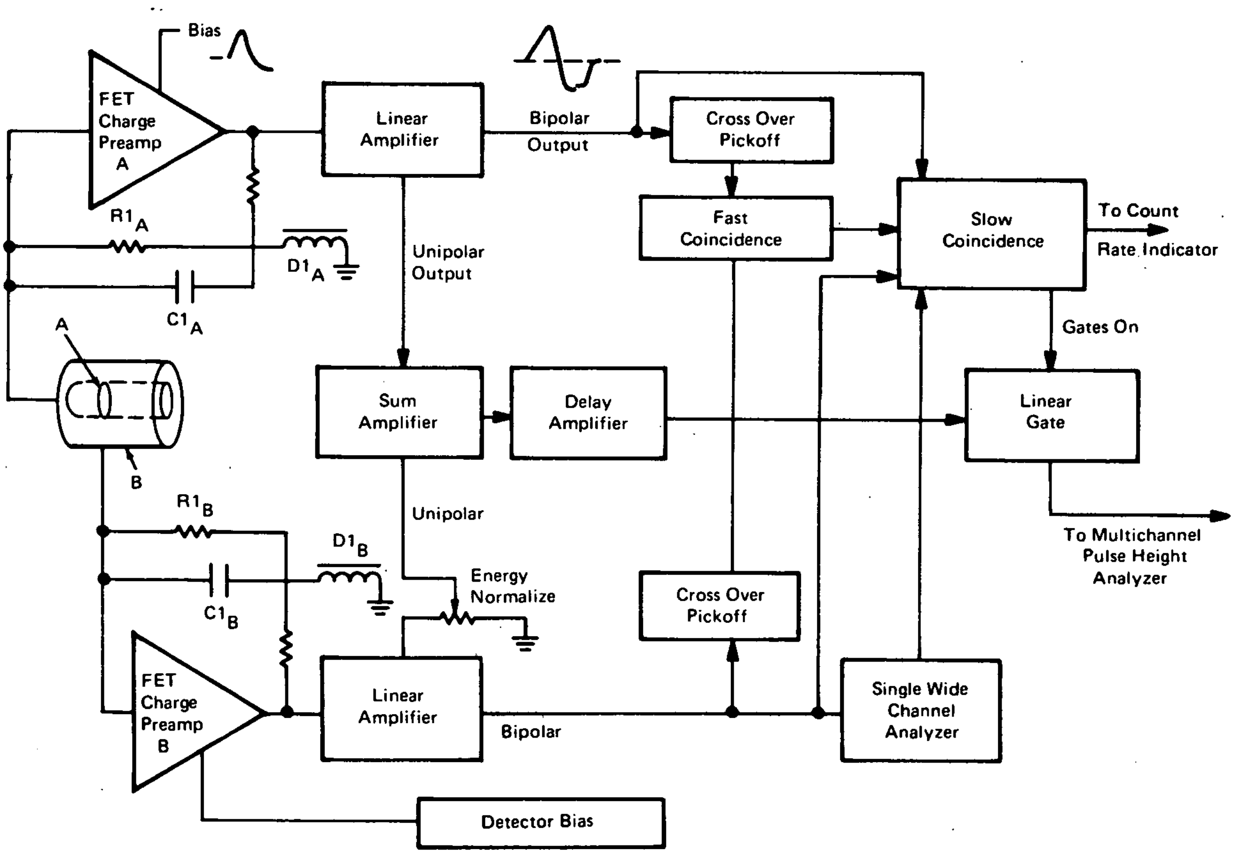
NASA TECH BRIEF
Marshall Space Flight Center

A Compton Scatter Attenuation Gamma Ray Spectrometer



A design has been proposed for a gamma ray spectrometer capable of gamma spectral measurements in radiation fields of 10^2 R/hr to 10^6 R/hr. Studies made on spectroscopy techniques and methods indicate that the Compton attenuation technique, utilizing semiconductor sum-Compton detectors, is the only practical method of performing gamma ray spectral measurements. The sum-Compton spectrometer consists of two or more separate detectors, with only the primary detector, designated detector A, exposed to the primary incident photon flux. The secondary detectors, designated detectors B, are largely shielded from the incident photons but are in close proximity to detector A. Detector A is envisioned to be a small diameter solid cylinder, and the radiation is incident on the end of this cylinder and collimation restricted to a diameter less than detector A diameter. Detector(s) B is a hollow cylindrical detector whose inside diameter is large enough to surround detector A.

(continued overleaf)

Both detectors A and B for the sum-Compton configuration are dc biased to approximately 500 volts through a resistance (not shown) to the bias supply. A capacitor, also not shown, is used to ac couple the FET charge sensitive preamplifier to the detector, and the detector to preamplifier distance should be as short as practical. The conventional feedback loop of preamplifier is through R_1 and C_1, and for good stability at high counting rates, time constant, $T = R_1 C_1$, should be approximately 10^{-5} seconds.

Additional wave shape clipping is obtained from the reflected pulse from the shorted delay line D_1. D_1 is not intended to provide a dc path to ground, and the reflected pulse should terminate in approximately 5×10^{-7} seconds after the pulse rise. This time interval is determined by the charge collection time for the detectors, which should approximate 2×10^{-7} seconds for the detector sizes under consideration. This delay line clipping is normally accomplished in the main linear amplifier, but is thought necessary for preamplifier stability at high count rates. Additional voltage and power gain, other than the charge to voltage conversion, will be provided in the preamplifier so that the linear amplifier may be located some distance away.

The linear amplifier is considered a standard delay line nonoverloading type, although the first delay line is incorporated in the preamplifier. The unipolar pulse is amplified in the first stage and routed to the sum amplifier. The later stage of the linear amplifier uses an identical delay line to D_1 to provide a bipolar output. Bipolar pulses are provided to a cross-over pickoff for precise timing and fast coincidence timing.

The unipolar output of the detector B linear amplifier is gain adjustable so that differences in the electron-hole pair creation energy of detectors A and B may be normalized. This is particularly necessary if the detectors are silicon and germanium. Such an adjustment is done in laboratory, and once established for a given detector pair, should not be changed.

The sum amplifier adds the energy pulses from the two detectors. This sum is delayed and presented to the linear gate. The linear gate passes the summed pulse, provided all conditions of fast and slow coincidence are met.

A single channel analyzer is provided in the detector B chain of electronics. The scattered radiation has a particular energy band, which permits reduction of accidental coincidence signals. As an example for detector B, the low-energy spectrometer range should be 40 to 400 keV and that of the high-energy spectrometer, 150 to 500 keV.

The output of the linear gate consists of the summed energy pulses which are analyzed. The count rate from the slow coincidence circuitry may be used to determine the Compton target mass and to trigger the multichannel pulse height analyzer for accepting pulses from the linear gate.

Notes:

1. It is suggested that commercially available electronic circuitry be used in the development model of the spectrometer.
2. Requests for further information may be directed to:
   Technology Utilization Officer
   Marshall Space Flight Center
   Code A&TS-TU
   Huntsville, Alabama 35812
   Reference: B72-10487

Patent status:

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

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